CHAPTER 8 INCREASING RENEWABLE ENERGY USE IN HAWAII

8.1 Why Renewable Energy Use Should Be Increased

Municipal solid waste, biomass, landfill methane, geothermal, hydroelectric, solar photovoltaic, and wind energy are renewable energy resources used to generate electricity in Hawaii and contribute to meeting the state's energy needs. Biomass is also used to produce process-heat, and solar heat is used for food drying and water heating. Hawaii's current use of renewable energy provides important diversification of the state's energy supply, helps keep funds spent for energy in the state, provides local jobs, and reduces environmental damage when compared with other forms of energy used for electricity generation. Additional use of renewable energy will add to these benefits and reduce Hawaii's dependence on imported fossil fuels.

Renewable energy can be less costly than fossil-fuel resources as evidenced by successful negotiation of power purchase agreements at or below utility avoided cost for municipal solid waste, geothermal, landfill methane, hydroelectric, and wind projects since 1989. On the other hand, when renewable resources are more costly than fossil-fuel resources, they increase electricity revenues. Whether this reduces economic performance, or costs more jobs than gained, depends upon the specifics of the renewable project. In addition, external benefits, such as reduced negative environmental impact, may lead to the selection of the renewable project over the less costly fossil-fuel option.

Another important advantage of renewable energy use is that most renewable resources do not produce greenhouse gases or are carbon neutral. Bagasse is an example of a renewable resource that is carbon neutral. While bagasse produces CO_2 when burned to generate electricity, growing sugar cane takes CO_2 out of the atmosphere, balancing the emissions. In 1996, the President's Council on Sustainable Development found that the relatively low impact of renewable energy technologies makes them ideal for sustainable economic development (Sissine 1999).

8.2 Renewable Energy Use in Hawaii

Biomass from sugar (bagasse), wind, hydroelectricity, geothermal, landfill methane, solar photovoltaics, and municipal solid waste were used to generate 7.9% of the state's electricity in 1997. Renewable energy technologies are discussed in Section 2.4. Statewide, 1997 renewable energy use in kWh was 16% greater than in 1990. Since the H-POWER facility on Oahu went into full operation in 1990, it has produced the largest percentage of the renewable energy sold to utilities. Bagasse was the second largest source of renewable energy until 1995, when it was surpassed by geothermal. Table A.28, in Appendix A, depicts the percentages of utility electricity from renewable sources, by utility, from 1990 to 1997. Table A.29 shows the percentages of utility electricity by renewable source for the same period.

8.3 Near-Term Prospects for Additional Renewable Energy

Over the last few years renewable energy developers have proposed new wind projects for Oahu, Maui, and Hawaii, and a large photovoltaic project for Hawaii. On Oahu, a wind farm with new wind turbines at the former Makani Uwila site was proposed. However, the Army has purchased the surrounding land as a training area and wants to purchase the existing non-operational wind sites and dismantle the idle wind turbines (Munger 1999b). The Army apparently sees them as potential hazards during training operations and would likely oppose re-powering of this site.

Also on Oahu, in 1995 the Air Force Space Command proposed a small wind farm at their Kaena Point facility. The environmental assessment circulated for agency review received no support. There was considerable opposition based upon concerns about heiau in the area, potential bird kills, and aesthetics. It was decided not to pursue the project (Munger 1999a, 19).

On Maui, Enron/Zond recently completed a Draft Environmental Impact Statement for the Kaheawa Pastures 20 MW wind farm. Enron/Zond is pursuing environmental permits for its site and has initiated negotiations with MECO for a power purchase agreement (Bollmeier 1999). An interconnection study will also be necessary to ensure operational compatibility with the MECO system (Munger 1999b).

On the Island of Hawaii, Enron/Zond and HELCO negotiated a power purchase agreement for a 10 MW wind farm at Kahua Ranch (Bollmeier 1999).

Also on the Big Island, another developer has proposed a 10 MW wind farm in the Hawi area and consideration is being given to re-powering the South Point wind farm. It appears that another project, a proposed 4 MW photovoltaic facility on the Big Island will not be pursued at this time (Munger 1999).

The new wind projects listed above are subject to interconnection studies to determine the limit of wind penetration appropriate to each utility system.

8.4 Recommended Renewable Energy Options for Hawaii

8.4.1 Background on the Renewable Energy Recommendations

8.4.1.1 *HES 1995* Project 3 Renewable Energy Assessment and Development Program Report

HES 1995 Project 3 developed a comprehensive assessment of Hawaii’s renewable energy resources and a long-range development strategy, *The Renewable Energy Assessment and Development Program Report* (DBEDT 1995b). The project first developed a Renewable Energy Resources Assessment Plan to determine constraints and requirements for wind, solar, biomass, hydroelectric, geothermal, wave, and ocean thermal energy conversion projects. Potential sites were identified and screened, and a plan was developed for additional monitoring of wind and solar conditions at several other potential sites to supplement existing data.

Renewable energy resource supply curves were developed by compiling cost and performance data on renewable energy systems and analyzing existing data on the Hawaii resources to allow comparison of the costs of various potential projects. Concurrently, a year's hourly wind and solar data were collected at selected locations statewide. Once data collection was completed, the resource supply curves were updated to reflect the new data. Recommended plans were then developed for each utility system for 1995 and 2005, based on expected cost and technology for each year.

The *HES 1995* Project 3 report was overly optimistic, concluding that "renewable energy projects can provide all the new generation required to meet projected energy demand increases between 1995 and 2005" (51). The study predicted that on the neighbor islands, this would be cost competitive under nominal cost assumptions. It predicted that on Oahu 30% of new needs could be met under nominal assumptions and that all new needs could be met under optimistic cost assumptions (51).

The report acknowledged that the "small size of Hawaii utility grids limits renewable energy development, particularly of intermittent technologies" (44). In identifying viable projects, the report assumed that renewables could meet or exceed 20% of peak demand without operating penalties, based upon a number of other studies. The report noted that "the results of such analyses are extremely variable and require detailed load flow and system stability analyses based on specific grid conditions to ensure utility reliability under all operating conditions" (44). Such studies were beyond the scope of *HES 1995* work, but the report suggested that "the wealth of potential renewable energy project development opportunities identified by this work should serve to encourage these activities (i.e., the necessary capacity studies) by utilities and other interested parties" (44).

It also should be noted that the *HES 1995* recommendations for ocean thermal energy conversion (OTEC) were based on ENERGY 2020 model runs that used overly ambitious cost claims made by an OTEC vendor. It is unlikely that such low costs are achievable in the near term. It is also clear that wave energy systems are unlikely to be acceptable to Hawaii's people, regardless of cost or technical feasibility. In addition, insufficient growth of the municipal solid waste stream, due in part to the success of recycling efforts, precludes further consideration of the previously recommended increase in H-POWER waste-to-energy generation on Oahu at this time.

8.4.1.2 Wind Penetration Studies by HECO Companies

In 1997, the HECO companies – HECO, HELCO, and MECO – completed a series of wind penetration studies to determine the amount of wind energy that could be accommodated on each system. These were "planning estimates" and involved many approximations and assumptions and very little actual performance data. There was insufficient operating data on the HECO and MECO systems to validate the assumptions, and the limited experience on the HELCO system suggested the analysis might have been too simplistic and the wind penetration estimate overstated (HECO 1999, 5). Nevertheless, they add another perspective to the problem that should be considered. The results of these studies were made available to DBEDT in July 1999 and were not available for use during the development of the *Hawaii Climate Change Action Plan* in 1997–1998 (DBEDT 1998b).

In 1980, HECO had contracted for an analysis of potential allowable wind penetration that was updated with additional data and extrapolated to 1998. The study estimated that 67 to 120 MW of wind-generated power could be accommodated on the HECO system (5). This was 3.9% to 7% of the HECO system's total 1998 capacity of 1,699 MW, which included both HECO-owned and NUG-owned generation.

The HELCO and MECO studies were performed in 1997. The HELCO study estimated allowable wind penetration at 4 to 14 MW, or 1.8% to 6.6% of the HELCO system's 1998 firm capacity. The MECO estimate was 4 to 11 MW, or 1.8% to 4.8% of the MECO system's firm capacity.

The consultant indicated that wind penetration might be increased by the use of new combined cycle units to regulate power on the system, by increasing spinning reserves, or by using energy storage. HECO and HELCO use automatic generation control (AGC), a system that facilitates power frequency control. The consultant noted that MECO might improve its ability to use wind if AGC were installed (10). These measures could improve system response to the minute-by-minute power fluctuations that occur in wind farm operation. The report also recommended additional data collection and more detailed analysis of specific projects (11). It suggested that future wind generation should be added incrementally. The consultant concluded "The data and experience will provide the technical, operational, and economic basis for determining how much more wind generation can be added" (12).

Energy storage options that would allow intermittent renewables to provide firm power include batteries, compressing air, electrolysis of water to produce hydrogen, flywheel storage, and pumped storage hydroelectricity. None of these appear to be cost effective at this time.

There are also a number of economic issues related to greater renewable energy use that are common to each utility system. To receive capacity payments, the operators of intermittent renewables such as wind and solar energy must provide some form of firm power backup to ensure that peak demand can be met when there is, respectively, little wind or sunshine. For example, HECO peak demand occurs in the 6–7 p.m. hour on most days. There is little or no sunshine at that time in Hawaii, especially in the winter, and wind speeds vary greatly by location.

Renewable energy's main attraction is reduced impact on the environment. (See Tables 8.1 to 8.4), greater use of renewable energy could avoid significant CO_2 emissions. Should oil prices again rise or should avoiding CO_2 emissions have economic value under a possible emission trading system, the fuel substitution value of both firm and intermittent renewables would increase, enhancing the economic value of these projects.

8.4.1.3 Use of *HES 2000* Renewable Energy Recommendations

In this section, *HES 2000* offers specific recommendations for renewable energy projects for each utility system. The recommendations are based upon the *HES 1995* study recommendations and data for biomass, hydro, photovoltaic, and wind systems only. These technologies are now commercially available. Cost and performance data developed in 1995 are presented for 1995 vintage systems and estimated data are presented for systems with capabilities expected to be available in 2005.

For HECO's second IRP, which was developed in 1996-1997, HECO's consultant used the DBEDT *HES 1995* consultant to provide wind data and limited hydro and geothermal data.

It must be stressed that in *HES 2000*, these recommendations represent portfolios of systems for consideration. Based upon available data, these projects appear to be the most promising. It is clear that updated cost data is needed (funds were not available to update the estimates contained in *HES 1995*) and that the interconnection feasibility of each intermittent system must be further evaluated, beyond the work done for the HECO companies.

It is recommended that the portfolios that follow be consulted in developing candidate plans for detailed analysis by each utility during the IRP process. At the same time, renewable energy developers could further examine some of these options for possible proposals for power purchase agreements.

8.4.2 Renewable Energy and Oahu

In 1997, renewable resources generated about 4.7% of Oahu's electricity. Most (4.3%) was provided by the H-POWER waste-to-energy facility; 0.2% was produced by the Kapaa landfill methane generator; and the remaining 0.2% came from Waialua Power, from greenwaste supplemented by heavy fuel oil and waste oil. Waialua Power ceased operations in July 1998. The capacity of H-POWER and Kapaa totaled 49 MW, or 2.8% of total HECO and NUG capacity on Oahu at the end of 1998. H-POWER provides firm power, while Kapaa's supply is provided as available.

8.4.2.1 Renewable Energy in HECO's IRP

Although HECO considered finalist plans with renewable energy in its first and second IRP processes, no renewable resources are currently planned (HECO 1998b, ES-8). In its second IRP, HECO considered wind in 20, 30, 40, 60, and 80 MW increments at Kahuku, and a 15 MW wind farm at Kaena Point. A 25 MW biomass plant was also evaluated (8-7). In addition, a study conducted for HECO, DBEDT, and the Department of Land and Natural Resources evaluated a pumped storage hydroelectric facility. Due to potential difficulties in acquiring necessary environmental and land use permits for the sites involved, the plan was screened out of the planning process (8-14 to 8-15).

HECO ultimately considered three finalist supply plans incorporating renewable resources (of 19 total). They were Plans F9 (20 MW) wind, F11 (25 MW biomass), and F13 (20 MW and 40 MW wind farms). The renewable plans ranked 12th, 14th, and 15th, respectively, in lowest total resource cost (TRC) of the 19 finalist plans (10-46). However, it should be noted that the difference between the TRC of the lowest and highest plans was only 3% – clearly within the range of error of the HECO models that were used to evaluate the plans. For example, the Unit Information Forms for the supply-side resources indicated that there was a plus or minus 10% "capital cost uncertainty" (Appendix J). The most expensive renewable plan (F13) had a TRC cost only 1.4% higher than the all fossil-fueled least-cost plans.

The renewable options were not part of HECO's preferred plan primarily due to their higher cost (despite the narrow range of cost estimates noted above), the intermittent nature of the wind options, and concerns about reliability of both the wind and biomass options. Instead, HECO indicated that it would issue a "Renewable Request for Proposal (RFP) to invite qualified renewable developers to submit proposals to provide energy to the HECO system in return for payments at or below HECO's avoided cost" (11-7). As of December 1999, the RFP had not been issued.

8.4.2.2 RECOMMENDATION: Consider Renewable Energy Options for Oahu

Suggested Lead Organizations: HECO and Renewable Energy Developers

The following recommended renewable energy options do not capture all potential projects that might be considered. They are offered as a starting point for further project identification and consideration by HECO and/or renewable energy developers.

Table 8.1 Selected Renewable Energy Options for Oahu

Estimated Costs

Name	Capacity (MW)	Capacity Factor 1995/2000	Capital Costs (Million $) 1995	Capital Costs (Million $) 2005	Capital Costs (1993$/kW) 1995	Capital Costs (1993$/kW) 2005
Wind at Kahuku (20)	**20**	**17.3%/21.7%**	**22.6**	**20.3**	**1,130**	**1,015**
Wind at Kaena Point	15	19.2%/24.0%	19.0	17.3	1,270	1,155
Wind at Kahuku (30)	30	17.3%/21.7%	34.0	30.5	1,132	1,017
Biomass at Waialua	**25**	**70%/70%**	**47.7**	**47.7**	**1,907**	**1,908**
Oahu Total	**90**		**123.3**	**115.8**		

Estimated Equivalent Capacity, Energy and CO_2 Savings, and Cost of CO_2 Savings

Name	Average Net Generation (GWh/Year) 1995	Average Net Generation (GWh/Year) 2005	Annual CO_2 Emissions Savings (Tons/Year) 1995	Annual CO_2 Emissions Savings (Tons/Year) 2005	Capital Cost per Ton of CO_2 Savings (Project Life) 1995	Capital Cost per Ton of CO_2 Savings (Project Life) 2005
Wind at Kahuku (20)	**30.4**	**38.0**	**29,760**	**37,225**	**$ 25.31**	**$ 18.18**
Wind at Kaena Point	25.2	31.6	24,725	30,927	**$ 25.67**	**$ 18.68**
Wind at Kahuku (30)	45.6	57.0	44,640	55,857	**$ 25.36**	**$ 18.21**
Biomass at Waialua	**153.3**	**153.3**	**150,234**	**150,234**	**$ 10.58**	**$ 10.58**
Oahu Total	**254.4**	**279.8**	**249,359**	**274,243**		

DBEDT 1995b

In Table 8.1, selected renewable energy options for Oahu are presented for consideration. The options were selected based on *HES 1995* resource supply curves. The 20 MW wind unit in bold corresponds to a recent developer proposal and the 25 MW biomass unit, also in bold, operated at a lower capacity until mid 1998, at Waialua. The table also shows the potential energy production and CO_2 emissions reductions offered by each option.

The cost data presented in Table 8.1 are taken from *HES 1995*. The options identified do not offer a major contribution to HECO's portfolio. If sites could be found for all 65 MW of intermittent wind projects, and if the 25 MW biomass unit were built, HECO would offset only 36.5 to 39.5 MW of fossil-fuel generation, or only 1.7 to 1.8% of planned HECO system firm capacity of 2,094 MW in 2017. The use of the recommended renewable energy projects could provide 254.4 to 279.8 GWh of electricity and reduce annual CO_2 emissions by 249,359 to 274,243 tons annually.

As noted in section 8.3, above, a proposal to build a small wind farm at Kaena Point was opposed in the environmental assessment phase and not pursued. The existing wind farm at Kahuku is no longer operational and the Army wants to incorporate the land into their training area. Thus, it will likely be necessary to find other suitable sites on Oahu. While there is considerable former sugar land, some areas may not have a good wind resource, or wind developers may have to compete with diversified agriculture or development. Future biomass projects face similar competition in finding land on which to grow energy crops.

8.4.3 Renewable Energy and the Island of Hawaii

The HELCO system has the greatest percentage of renewable energy in Hawaii. Geothermal provided 23% of electricity in 1997, followed by hydroelectricity at 5% and wind at 2%. The geothermal energy was firm, baseload power, while the hydro and wind were intermittent.

8.4.3.1 Renewable Energy in HELCO's IRP

During development of its second IRP, HELCO considered 7 of 14 finalist plans that offered a variety of renewable energy resources. These included 10 MW of additional wind, 4 MW of photovoltaics, 13.8 MW of hydroelectricity, up to 50 MW of biomass (in 25 MW units), 30 MW pumped storage hydro, and 25 MW of geothermal (HELCO 1998, 8-5).

HELCO's preferred plan consisted of 81.6 MW of oil-fired units; however, Alternate Plan A called for possible acquisition of additional wind and photovoltaic facilities. HELCO indicated that to increase renewable energy development and public awareness and to meet the state energy policy objectives for increased renewable energy, it would continue to pursue renewable energy installations. Since that time, HELCO concluded an agreement with Enron/Zond for a 10 MW wind farm at Kahua Ranch and additional proposals are under discussion.

The range of estimated total resource costs between the 14 finalist plans was relatively narrow, at 7.7%. The “Minimize Oil” plan was the most expensive of the finalist plans. It included 10 MW wind and two 25 MW biomass units. While HELCO planned to return its Puna steam unit from standby in all plans, and to install the steam recovery unit on its planned Keahole unit, there was only one fossil unit in this plan, a 22 MW unit to be installed in 2016.

8.4.3.2 RECOMMENDATION: Consider Renewable Energy Options for the Island of Hawaii

Suggested Lead Organizations: HELCO and Renewable Developers

The following recommended renewable energy options do not capture all potential projects that might be considered. They are offered as a starting point for further project identification and consideration by the utility and renewable energy developers.

Table 8.2 depicts renewable energy options for the Big Island, selected based on *HES 1995* resource supply curves. The projects in bold were reportedly under recent negotiation for power purchase agreements. The 20 MW wind farm for the Kahua site was recommended by the *HES 1995* Project 3 report, but Zond/Enron has signed a power purchase agreement for a 10 MW wind farm at that location. This project is contingent upon extension of federal tax credits for renewable energy that expired on July 1, 1999. Further analysis is needed to determine whether HELCO’s system can handle additional wind generation.

Table 8.2 Selected Renewable Energy Options for the Island of Hawaii

Estimated Costs

Name	Capacity (MW)	Capacity Factor 1995/2000	Capital Costs (Million $) 1995	Capital Costs (Million $) 2005	Capital Costs (1993$/kW) 1995	Capital Costs (1993$/kW) 2005
Wind at Kahua Ranch	**20.0**	**23%/29%**	**24.7**	**22.4**	**1,233**	**1,119**
Photovoltaic (Fixed) at Waikoloa	**4.0**	**43%/54%**	**24.0**	**16.1**	**6,012**	**4,026**
Wind at North Kohala	15.0	43%/54%	18.6	16.9	1,241	1,127
Wind at Lalamilo Wells	50.0	35%/44%	56.4	50.6	1,127	1,012
Hydro at Umauma Stream	13.8	33%/33%	24.0	24.0	1,736	1,736
Geothermal	50.0	none/83%	not estimated	121.0	not estimated	2,420
Biomass at Hilo Coast	50.0	none/70%	not estimated	96.9	not estimated	1,938
Hawaii Total	**202.8**		**147.6**	**130.0**	**11,348.1**	**9,020.5**

Estimated Equivalent Capacity, Energy and CO_2 Savings, and Cost of CO_2 Savings

Name	Avg. Net Generation (GWh/Year) 1995	Avg. Net Generation (GWh/Year) 2005	Annual CO_2 Emissions Savings (Tons/Year) 1995	Annual CO_2 Emissions Savings (Tons/Year) 2005	Capital Cost per Ton of CO_2 Savings (Project Life) 1995	Capital Cost per Ton of CO_2 Savings (Project Life) 2005
Wind at Kahua Ranch	**40.5**	**50.7**	**39,920**	**49,934**	**$ 20.58**	**$ 14.95**
Photovoltaic (Fixed) at Waikoloa	**9.1**	**8.5**	**9,009**	**8,335**	**$ 88.98**	**$ 64.40**
Wind at North Kohala	56.9	71.2	56,051	70,110	$ 11.07	$ 8.04
Wind at Lalamilo Wells	154.2	192.1	151,870	189,205	$ 12.37	$ 8.92
Hydro at Umauma Stream	40.2	40.2	39,596	39,596	$ 20.16	$ 20.16
Geothermal	n/a	362.3	n/a	356,879	n/a	$ 11.30
Biomass at Hilo Coast	n/a	306.6	n/a	302,001	n/a	$ 10.70
Hawaii Total	**301.0**	**1,031.5**	**296,447**	**1,016,060**		

DBEDT 1995b

A 50 MW biomass electric plant and an additional 50 MW of geothermal are recommended for consideration. If these or similar units were built, they could displace about 82% of HELCO's planned new fossil-fueled generation. Both units would have to be capable of operating at less than full capacity to accommodate HELCO's low nighttime peak. They would also fit the HELCO system better if built in 25 MW increments to simplify maintenance scheduling. Implementing two 25 MW units would also reduce the potential impact of unit malfunction on the system. To support the biomass option, land would need to be obtained to support cultivation of energy crops, in competition with other projects such as forestry and diversified agriculture. Based upon the recently released wind penetration analysis, it appears unlikely that all of the wind capacity identified above for consideration could be employed. The analysis suggested that 4 to 14 MW might be accommodated on the HELCO system. Smaller increments at each location could be considered and, as recommended by the HELCO Wind Penetration Analysis, projects would need to be evaluated individually and incrementally (HECO 1999).

As shown on Table 8.2, renewable energy could produce significant oil savings and reduce CO_2 emissions from 296,447 to 1,016,060 tons per year. Should oil prices again rise or should avoiding CO_2 emissions come under an emission trading system, the value of both firm and intermittent renewables would increase.

8.4.4 Renewable Energy and Kauai

KE uses the second greatest percentage of renewable energy, including 10 MW of baseload bagasse-generated power and 2% hydroelectricity.

8.4.4.1 Renewable Energy in KE's IRP

In its IRP action plan, KE committed to seeking opportunities for third party development of photovoltaic, solar, hydro, and wind generation applications. KE was to review existing draft purchase contracts to negotiate NUG renewable options and to actively participate in state government renewable energy efforts (KE 1997, 2-3). Renewable resources were not selected from among the responses to RFPs issued by KE. Green Islands Corporation proposed a plasma arc waste-to-energy plant that would receive energy-only payments.

8.4.4.2 RECOMMENDATION: Consider Renewable Energy Options for Kauai

Suggested Lead Organizations: KE and Renewable Developers

The following recommended renewable energy options do not capture all potential projects that might be considered. They are offered as a starting point for further project identification and consideration by the utility and renewable energy developers.

Table 8.3 lists selected renewable energy options for Kauai, based on the *HES 1995* resource supply curves. The MSW plant at Kaumakani, in bold on Table 8.3, represents the plasma arc plant proposed by Plasma Environmental

Technologies. A biomass plant is also listed. If the MSW plant were developed to provide firm power (perhaps with an energy crop supplement to MSW), together with the biomass plant, KE could enjoy 50 MW of firm, renewable energy. This would provide for all but 10.4 MW of the fossil-fuel power scheduled for deployment through 2017.

Table 8.3 Selected Renewable Energy Options for Kauai

Estimated Costs

Name	Capacity (MW)	Capacity Factor 1995/2005	Capital Costs (Million $) 1995	Capital Costs (Million $) 2005	Capital Costs (1993$/kW) 1995	Capital Costs (1993$/kW) 2005
MSW plant at Kaumakani	**25**	**none/70%**	not estimated	**48.1**	not estimated	**1,922**
Wind at North Hanapepe	10	21%/26%	12.0	10.7	1,198	1,074
Hydro at Wailua River	7	28%/28%	11.3	11.3	1,709	1,709
Wind at Port Allen	5	18%/21%	6.2	5.4	1,241	1,087
Biomass at Kaumakani	25	none/70%	not estimated	48.1	not estimated	1,922
Kauai Total	**71.6**		**29.5**	**123.6**	**4,148.8**	**7,715**

Estimated Equivalent Capacity, Energy and CO_2 Savings, and Cost of CO_2 Savings

Name	Avg. Net Generation (GWh/Year) 1995	Avg. Net Generation (GWh/Year) 2005	Annual CO_2 Emissions Savings (Tons/Year) 1995	Annual CO_2 Emissions Savings (Tons/Year) 2005	Capital Cost per Ton of CO_2 Savings (Project Life) 1995	Capital Cost per Ton of CO_2 Savings (Project Life) 2005
MSW plant at Kaumakani	**n/a**	**153.3**	**n/a**	**151,001**	**n/a**	**$ 10.61**
Wind at North Hanapepe	18.3	22.6	17,978	22,263	$ 22.21	$ 16.07
Hydro at Wailua River	16.4	16.4	16,188	16,188	$ 23.23	$ 23.23
Wind at Port Allen	7.8	9.3	7,647	9,181	$ 27.05	$ 19.74
Biomass at Kaumakani	n/a	153.3	n/a	151,001	n/a	$ 10.61
Kauai Total	**42.5**	**355.0**	**41,813**	**349,634**		

DBEDT 1995b

8.4.5 Renewable Energy and Maui

MECO used 5% renewable energy in 1997, ranking third in the state on a percentage basis. This included 4% baseload bagasse generation and 1% intermittent hydroelectricity.

8.4.5.1 Renewable Energy in MECO's IRP

As noted in Chapter 7, MECO is in the process of developing its second IRP, which it plans to complete by May 31, 2000. In work on the second IRP, MECO had developed a list of finalist plans that will likely be considered, along with generator life-extension, as options for the future. Seven of the 10 plans presented to the Advisory Group included renewable energy components. Plan F2 had 10 MW of wind, F3 had two 10 MW wind farms, F5 had a 4 MW photovoltaic system, F7 had 10 MW of wind and a 30 MW pumped-storage hydroelectric system, F8 had a 25 MW biomass plant, and F9 had 4 MW photovoltaics, 10 MW wind, 30 MW pumped storage hydro, and a 25 MW biomass plant. A tenth plan, based upon that modeled in the *Hawaii Climate Change Action Plan* (DBEDT 1998b), had 20 MW wind in two wind farms and a 25 MW biomass plant. During a discussion of the finalist plans in April 1999, the Maui County representative proposed a “Maui County Plan” that included 4 MW photovoltaics, 20 MW wind, and 24 MW of biomass (MECO 1999).

There was a relatively narrow range of 15.8% between the lowest-cost all-fossil-fuel plan and the F9 “Maximum Renewables Plan”. The Maui County Plan was about 9.86% more expensive than F9. The range between the total resource cost of the lowest cost fossil plan and F2, F3, and F5 was only 1.16%, suggesting that these wind and PV plans would increase costs minimally, if at all.

8.4.5.2 RECOMMENDATION: Consider Renewable Energy Options for Maui

Suggested Lead Organizations: MECO and Renewable Developers

The following recommended renewable energy options do not capture all potential projects that might be considered. They are offered as a starting point for further project identification and consideration by the utility and renewable energy developers.

Table 8.4 presents selected renewable energy options for Maui, based on HES 1995 resource supply curves. The 25 MW biomass plant would be the only firm power renewable unit on the system, representing only 25 of the 272.4 MW in additional units that were being considered in ongoing work on MECO’s second IRP (MECO 1999). This unit would be the nominal equivalent of the 27.9 MW diesel that was planned for installation in 2010. Land for energy crops would need to be obtained. Table 8. 6 also lists forty megawatts of wind, but the MECO Wind Penetration Analysis suggests that only 4 to 11 MW of wind could operate on the MECO system. Each potential increment would need to be evaluated individually (HECO 1999).

Table 8.4 Selected Renewable Energy Options for Maui

Estimated Costs

Name	Capacity (MW)	Capacity Factor 1995/2005	Capital Costs (Million $) 1995	Capital Costs (Million $) 2005	Capital Costs (1993$/kW) 1995	Capital Costs (1993$/kW) 2005
Wind at West Maui	**20**	**14%/18%**	**23.5**	**21.1**	**1,176**	**1,053**
Biomass at Puunene	25	70%/70%	66.7	68.7	2,667	2,749
Wind at NW Haleakala	20	20%/24%	23.1	20.6	1,153	1,031
Maui Total	65		113.2	110.4	4,995.8	4,833.7

Estimated Equivalent Capacity, Energy and CO_2 Savings, and Cost of CO_2 Savings

Name	Avg. Net Generation (GWh/Year) 1995	Avg. Net Generation (GWh/Year) 2005	Annual CO_2 Emissions Savings (Tons/Year) 1995	Annual CO_2 Emissions Savings (Tons/Year) 2005	Capital Cost per Ton of CO_2 Savings (Project Life) 1995	Capital Cost per Ton of CO_2 Savings (Project Life) 2005
Wind at West Maui	**25**	**30.8**	**24,525**	**30,370**	$ 31.97	**$ 23.12**
Biomass at Puunene	153.3	153.3	151,001	151,001	$ 14.72	$ 15.17
Wind at NW Haleakala	34.2	42.4	33,734	41,774	$ 22.79	$ 16.46
Maui Total	**212.4**	**226.5**	**209,259**	**223,144**		

DBEDT 1995b

8.5 Recommended Actions to Increase Renewable Energy Use in Hawaii

8.5.1 The Need for Accurate Cost Data on Renewables for Integrated Resource Planning

8.5.1.1 RECOMMENDATION: Obtain Accurate Cost Data on Renewable Energy Options for Integrated Resource Planning

Suggested Lead Organizations: Electric Utilities

As part of the IRP process, the electric utilities should obtain accurate, up-to-date cost information for renewable energy options under consideration. For their second IRPs, supply-side consultants for HECO, HELCO, and MECO used DBEDT's consultant for wind data and portions of hydro and geothermal data.

While the utilities frequently caution that renewable energy will increase electricity costs to consumers, up-to-date information is needed to ensure accuracy. The fact that a geothermal developer, a hydroelectricity developer, and a wind developer were able to obtain power purchase agreements at or below the utility cost calls the utility view into question. Accurate data is needed for the IRP process, and obtaining that data is the responsibility of the utility doing the planning.

8.5.2 Tax Credits to Encourage Renewable Energy Use

8.5.2.1 RECOMMENDATION: Continue to Assess the Need for Renewable Energy State Income Tax Credits beyond 2003

Suggested Lead Organizations: DBEDT, Electric Utilities, and renewable energy industry

The State of Hawaii began offering renewable energy tax credits in 1977, starting with an energy-device tax credit that allowed a state resident to claim 10% of the cost of a solar water heater against his or her state income tax. At the time, the state tax credit supplemented a federal tax credit of 30%, but the federal credit ended in 1985.

There have been many changes in the State Energy Tax Credit over the years. Current credits, extended in 1998 for five years (to 2003), are summarized in Table 8.5. Most of the credits have gone for solar water heating systems, although some photovoltaic systems and photovoltaic-powered ceiling vent systems have also employed the credit. The need for further extension of the tax credit should be evaluated and recommendations made to the Governor and Legislature before the 2003 Legislative session.

Table 8.5 Hawaii Energy Tax Credits

Technology	State Income Tax Credit	Maximum Amount
Solar Systems (Thermal and Photovoltaic)		
Single Family Home	35%	$1,750
Mulit-Unit Dwelling Unit	35%	$350
Hotels, Commercial, and Industrial Facilities	35%	Actual Cost
Heat Pumps		
Single Family Home	20%	$400
Mulit-Unit Dwelling Unit	20%	$200
Hotels, Commercial, and Industrial Facilities	20%	Actual Cost
Wind System	20%	Actual Cost
Ice Storage System*	50%	Actual Cost

DBEDT 1996c

*Note: Ice storage is not a renewable energy system, but tax credits are offered. Ice storage allows use of off-peak generation or gas refrigeration to be used to produce ice to be used for cooling at on-peak times.

The Hawaii Energy Tax credits contributed to the installation of 9,029 solar water heaters through utility demand-side management programs in 1998 and through July 1999. Of these, 6,415 were on the HECO system, 1,119 were on the HELCO system, and 1,495 were on the MECO system (Munger 1999a, 31).

8.5.2.2 RECOMMENDATION: Encourage Renewable Energy Use through Federal Tax Credits

Suggested Lead Organization: Hawaii Congressional Delegation

The U.S. government offered residential solar tax credits and residential and business tax credits for wind energy until December 31, 1985. Business investment tax credits applicable to renewable projects were extended repeatedly throughout the 1980s. Current federal tax credits include:

- Section 1996 of the *Energy Policy Act of 1992* (EPACT) (P.L 102-486) extended 10% business tax credits for solar and geothermal equipment indefinitely; and
- Section 1914 of EPACT provided a tax “production” credit of 1.5 cents per kWh for electricity produced by wind and closed-loop biomass systems that expires in 1999 (Sissine 1999).

The Administration’s FY 1999 Climate Change Technology Initiative sought $6.3 billion in tax incentives over the next five years for energy efficiency, cleaner energy sources, and renewable energy programs (Sissine 1999). Such programs have great potential in increasing the cost-competitiveness of renewable energy resources in Hawaii and should be supported.

8.5.3 Additional Recommendations

8.5.3.1 RECOMMENDATION: Continue to Increase the Use of Solar Water Heating

Suggested Lead Organizations: Electric Utilities and Solar Water Heating Industry

A large base of solar water heating in Hawaii was installed prior to the current residential water heating DSM programs offered by the electric utilities. Utility DSM incentives and the renewable energy tax exemption complement each other in encouraging installation of additional solar water heating. Significant additional fuel savings and emissions reductions are likely possible from new solar water heating systems. See the discussion of utility DSM programs in Chapter 11.

8.5.3.2 RECOMMENDATION: Implement Recommendations of Renewable Resource Docket

Suggested Lead Organizations: Public Utilities Commission, Counties, and organizations identified in report

Hawaii's 1994 Legislature adopted *Senate Concurrent Resolution No. 40*, which requested the Public Utilities Commission to initiate an informational docket to facilitate the development and use of renewable resources in the State of Hawaii. The Commission opened Docket No. 94-0226 to accomplish the following objectives:

- Study the policies, statutes, and programs of other jurisdictions, as well as the strategies employed by these jurisdictions to implement the development of renewable energy resources;
- Examine policies presently employed by the State of Hawaii with respect to facilitating the utilization of renewable energy resources;
- Identify barriers to the development of renewables in Hawaii; and
- Formulate strategies to remove the barriers and implement the use of renewables in Hawaii. (PUC 1996, 1)

There were twenty-one parties to the collaborative, which produced a two-part report entitled *Strategies to Facilitate the Development and Use of Renewable Energy Resources in Hawaii* (PUC 1996). Part one was a study by the National Renewable Energy Laboratory (NREL), "Renewable Energy Policy Options for the State of Hawaii". The second part, the Collaborative Document, summarized the parties' collaborative efforts to identify barriers and formulate strategies for the use of renewables in Hawaii.

NREL Report: Renewable Energy Policy Options for Hawaii. NREL cited the following primary impediments to the successful development of renewable energy resources in Hawaii:

- Renewable energy systems require a large initial capital investment;

- Electric utilities fail to incorporate the benefits of renewables into their market decisions; and
- Market power is concentrated in the hands of the electric utility companies, impeding investments in renewables (2).

The report cited three policy measures commonly used to foster renewable energy development in other states that have been used by the State of Hawaii:

- Financial incentives such as tax credits, tax exemptions, or direct loans and grants, which lower the cost of renewable energy systems;
- Power purchase contract rules, which assist non-utility developers in securing contracts for the sale of power to a utility by guiding contract negotiations and the determination of "avoided cost" payments; and
- Integrated resource planning requirements for utilities to consider renewable energy among the range of generation alternatives when developing their least-cost plan (2).

NREL identified a number of basic strategies implemented or considered by other states to further the deployment of renewable energy resources. These included net-metering, renewable energy set-asides, legislative requirements for renewables, direct access to the grid for renewable energy suppliers, risk allocation, targeted financial incentives and disincentives for utilities, system benefits charges, "green" RFPs, and renewables portfolio standards. The following specific strategies were suggested for Hawaii:

- A clear pronouncement by the State that renewable energy development remains an important objective, and the establishment of a concrete goal for renewable energy policies;[a]
- Establishment by the State of an official preference that all new generating capacity employ renewable energy resources unless it is demonstrated that a specific use is not in the public interest;
- Development of financial incentives to utilities, renewable energy providers, and customers, funded from general revenues or by a "system benefit charge" assessed on all electricity customers;
- Establishment of a portfolio standard imposing a minimum renewable energy requirement for the State's electricity mix;
- Development by the utilities of a competitive green power product that allows customers to exercise voluntarily a preference for electricity from renewable energy sources;

[a] Note: This was accomplished through the addition of the statutory energy objective "increased energy self-sufficiency where the ratio of indigenous to imported energy use is increased" by Act 96, Session Laws of Hawaii 1994.

- Authorization for alternative renewable energy providers to supply renewable energy service options directly to a utility's wholesale and retail customers; and
- Establishment of a net energy metering policy that allows customers to offset high retail rates with small-scale renewable electricity systems (3-4).

The Collaborative Document. The Collaborative document identified real and perceived barriers to renewable resource development and developed a list of targeted recommendations. It should be pointed out that despite its name, the Collaborative Document is not a consensus document and does not represent unanimous agreement by all parties.

Barriers included the following:

- Insufficient avoided cost prices for developer financing;
- Operational limitations on the amount of renewable energy;
- Complex and lengthy permitting processes and site availability
- Form of price offered to developers does not facilitate financing;
- Lack of new renewables in current integrated resource plans;
- Protracted nature of purchase power negotiations;
- Lack of direct consumer access to renewable power;
- Potential negative environmental and societal impacts;
- Certain renewable and storage technologies insufficiently mature to be economically viable; and
- Fragmented and overlapping efforts by the State in renewable energy research, development, demonstration, and commercialization (4-5).

The Collaborative document listed key strategies for consideration by the Legislature, the Commission, the utilities, DBEDT, the Counties, and renewable energy developers. The Commission has taken no direct action on the report other than to provide it to the State Legislature, but the recommendations remain valid.

8.5.3.3 RECOMMENDATION:, Consider Implementing a Renewable Portfolio Standard, a Public Benefits Charge, or Green Pricing to Increase Renewable Energy Use

Suggested Lead Organization: Legislature and Public Utilities Commission

Renewable resources require support until they become fully cost-competitive. Methods for ensuring the future promotion, development, and use of Hawaii's renewable resources could include the use of options such as a renewable portfolio standard (RPS), public benefit funding for installation of renewable systems, or allowing Hawaii's utilities to market "green" power.

Renewable Portfolio Standard. A renewable portfolio standard, or RPS, requires that a certain percentage of electricity generation be obtained from renewable resources. An RPS could be set and phased in over a period of time. These percentages should be studied further to determine what values are appropriate and whether different standards might be necessary on different islands. The percentages could be adjusted over time, if needed, to remain consistent with State renewable energy goals and to respond to customer demand for renewable energy alternatives. A statewide trading program could also be established. This would allow the standard to be met on any island, allowing selection of the lowest cost options.

To reduce demand for non-renewable resources, the RPS could provide incentives to stimulate use of solar water heating or other non-grid-connected systems by end users. Credit could be given for renewable resources behind an end-user’s meter. This would be facilitated by net metering, already instituted in many states, and also called for in the Clinton Administration’s *Comprehensive Electricity Competition Act*.

In addition, the *Act* would establish a Federal RPS to guarantee that a minimum level of renewable generation is developed in the United States. The RPS would require sellers to provide a percentage of their new generation from non-hydroelectric renewable technologies, including wind, solar, biomass, or geothermal. The RPS for 2000–2004 would be set a the current ratio of RPS-eligible generation to retail electricity sales. A standard between the initial RPS and less than 7.5% would be set by the Secretary of Energy for 2005–2009. In 2010–2015, the RPS would be 7.5%. With its abundant renewable energy resources, Hawaii could consider a greater amount. The national RPS proposed in the *Act* would expire in 2015, when it is expected that the economics and benefits of renewable energy resources will be fully established (USDOE 1999, 4).

Public Benefits Funding of Renewable Energy Resources. State public utilities commissions have historically used public benefits funding to finance renewable energy programs. Utilities have been required to collect in their rates, funds to pay for renewable energy programs, as well as energy efficiency programs and energy research and development programs.

In the Clinton Administration’s *Comprehensive Electricity Competition Act*, submitted to Congress in April 1999, contained a provision for a Public Benefits Fund administered by a Joint Board that would disburse matching funds to States for low-income assistance for electricity service, energy conservation and efficiency measures, consumer education, and development of emerging electricity generation technologies (USDOE 1999, 4). The latter could include renewable energy. While the proposed *Act* would not require Hawaii to have a competitive system, the matching funds may be available under the current structure or under a restructured competitive system.

Marketing "Green" Power. Marketing "green" power is a means of increasing the use of renewables. Customer surveys nationally and in Hawaii have indicated that many people are willing to pay more for electricity from renewable sources.

In a form of “green” power in Hawaii, the HECO companies are funding “Sunpower for Schools”, the installation of photovoltaic units on public schools, through voluntary ratepayer payments. While a very small percentage of customers participate, it is expected that greater numbers would want to buy “green power” for their own homes or businesses if offered the opportunity. The utilities could be permitted to offer customers the option of buying electricity produced by renewable resources in various percentages. Emissions disclosure to consumers is one method for stimulating consumer choice for green power options.